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Published:
— *With international search report.*
— *With amended claims and statement.*

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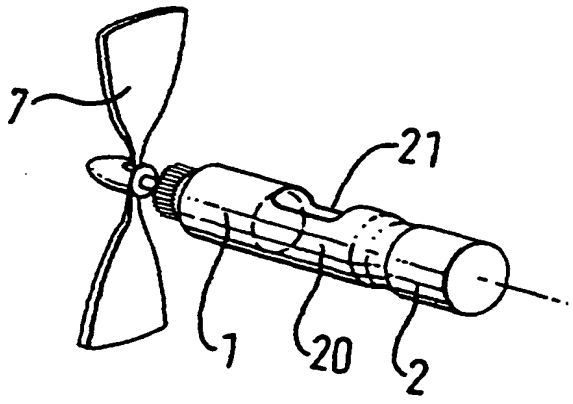
(54) Title: POWER ASSISTED TOY AIRCRAFT



(57) Abstract: An electrically power-assisted toy aircraft construction consists of a power assist module (1) which can be releasably attached to a single piece lightweight aircraft body (12) such that the assembled power assist module and body constitute an aerodynamic glider and wherein the power assist module (1) comprises a propeller (7), an electric motor adapted to rotate the propeller and a charge storage device (1) adapted to power the electric motor. The power assist module may be re-used with a succession of aircraft bodies, e.g. when a body is damaged during use. The body may be very simply molded out of lightweight material , for example polystyrene foam material.

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POWER ASSISTED TOY AIRCRAFT

This invention relates to power assisted toy aircraft.

Toy aircraft are known in two distinct varieties, viz. those which are merely models or representations of aircraft and which do not have any aerodynamic capability and those which are constructed to be able to fly, at least to the extent of being able to glide. The latter are suitable for use in activity play where the user launches the aircraft and sees it fly rather than imaginative play where the toy aircraft is e.g. moved along a surface, carried through the air, or parked on a model airfield.

The length of the flight path from release to landing is an important criterion of satisfactory play. A simple glide path is necessarily limited and attempts have accordingly been made to provide an increased range to toy aircraft by providing them with some form of power. The classic simple approach consists of a rubber band fixed near the rear of the craft and connected to a shaft extending from a propeller rotatably mounted at the front of the craft. Winding the propeller winds up the rubber band and, on its

release, the stored energy as the band untwists turns the propeller enabling such craft to take off and then glide to a landing, or to travel some distance if launched above ground by hand. Such aircraft are well-known, but they suffer from not looking very much like real aircraft and additionally from the mechanical requirement of having to provide a mounting near the rear end which can withstand considerable tension.

Model aircraft provided with miniaturised internal combustion engines have been known for decades, but remain the province of enthusiasts and sophisticated modellers and are unsuitable for the smaller child. The performance, particularly if the aircraft is radio controlled, naturally resembles that of a real aircraft. The cost, however, is substantial.

In order to provide toy aircraft which have a certain amount of power assistance, but which basically function as gliders, two systems have been developed in recent years, viz. so-called air-powered aircraft and electrically powered aircraft. The former type is described in GB-A-2041456.

Although such aircraft fly satisfactorily, the pleasure of playing with them is diminished by the necessity after each flight to pump up the reservoir again to an appropriate pressure. Although this can be done with very simple means such as a simple hand pump, it inevitably takes some time and effort.

In contrast, electric motors with a high power to weight ratio have been developed which can be used to turn a propeller for a short period of time based on a simple power supply in the form of a rechargeable capacitor. A normal battery power supply would be too heavy, and lightweight electrical cells are expensive. Although

charging a capacitor of adequate storage capacity can take several seconds, it is generally easier and quicker than pumping up an air reservoir.

A particular problem with all toy aircraft is that however carefully operated and launched, they tend to fly into things. This can cause damage, particularly if the craft itself is, as is customary, of extremely light weight or even flimsy construction. The likelihood of damage has restricted the widespread commercialisation of such aircraft.

We have now found that by careful design, it is possible to produce electrically power-assisted toy aircraft which can be produced extremely inexpensively and which can avoid various of the disadvantages noted above.

According to the present invention, there is provided an electrically power-assisted toy aircraft construction consisting of a power assist module which can be releasably attached to a single piece lightweight aircraft body such that the assembled power assist module and body constitute an aerodynamic glider and wherein the power assist module comprises a propeller, an electric motor adapted to rotate the propeller and a charge storage device adapted to power the electric motor.

Operating on this basis, it is possible to design a variety of toy aircraft where the power assist module may be re-used with a succession of aircraft bodies. These may be the same or different, but each may be very simply moulded out of lightweight material, for example polystyrene foam material. Preferably the aircraft body takes the form of a conventional aircraft with fuselage, two wings, a tail and a fin with an aperture extending longitudinally from the front of the fuselage into which

the power assist module is a press fit. Preferably the power assist module is constructed in the shape of a cylinder which can be press fitted into such an aperture in the front of a fuselage with the propeller located on the front of the assembled aircraft. In such an arrangement, conveniently, the power module assembly consists of a linear arrangement of, in sequence, a charge storage device, e.g. a capacitor or lightweight battery, a motor connected thereto, a propeller drive gearing, a propeller shaft and a propeller. If desired, there may be a reduction gear unit between the motor and the propeller shaft. This linear arrangement enables electrical charge to be supplied to the charge storage device very simply by providing a pair of electrical contacts between the charge storage device and the motor which may be accessed using a suitable contact-bearing member inserted in a generally radial direction to the longitudinal axis of such a power assist unit. The fuselage of the body portion of the aircraft may contain an appropriate aperture so that when the power assist unit is inserted into the fuselage, the contacts are accessible via the aperture.

In an alternative design, the propeller may be of small diameter, and mounted on a frame of slightly larger diameter, the frame carrying a drive motor and charge storage device. Such a unit may be inserted into a cylindrical hole running fore to aft in a simulator aircraft body, giving the appearance of a stably jet-propelled aircraft. The frame is a press fit in the cylindrical hole.

The performance of toy aircraft according to the invention may be further enhanced by fitting a pair of rotors to the ends of the wings to provide enhanced lift during gliding flight by means of the autogiro action generated. The rotors are freely rotatable about

vertical axles. Fitting such rotors enables the same performance to be achieved with a reduced wingspan.

Where the charge storage device is a capacitor, this is preferably simply supplied with charge from a battery pack at an appropriate voltage. The battery pack is, understandably, far too heavy to be incorporated in the aircraft itself, but it may include a contact-bearing member with an appropriate pair of contacts for bringing into electrical contact with the contacts in the power assist module. The contact-bearing member may extend from a casing in which a set of batteries, i.e. individual cells, may be inserted. Alternatively, if the charge storage device is a lightweight rechargeable cell, it may be charged using a conventional charger.

In use, the user holds the aircraft in one hand and inserts the contact-bearing member appropriately to make contact with the contacts in the power assist module. Doing that does two things, viz. it provides electrical charge to the charge storage device, e.g. a large capacity capacitor, and, at the same time (unless insertion of the member breaks the circuit to the electric motor), it causes the electric motor to turn and accordingly the propeller to spin. This is not in fact disadvantageous since it means that none of the charge stored in the charge storage device is used to accelerate the propeller to its operational speed. Rather, once that operational speed is reached (and this occurs at the same time as the charge storage device becomes fully charged), the contact-bearing member is simply released from the power assist module, e.g. by simply pulling out of a socket therein, and the aircraft itself then released to fly appropriately, first with power assist and then, when the charge from the charge storage device has been used up by the motor, in a glide path to an eventual, hopefully safe, landing. If,

despite whatever care is exercised by the user, the aircraft crashes in such a way as to damage the aerodynamic surfaces to such an extent that the assembly can no longer fly, the body portion is simply discarded and the power assist module placed in a fresh one. The power assist module is, naturally, built sufficiently robustly to withstand impact at normal flight speed into a hard surface.

Care must be taken to ensure that the propeller is turned in the correct direction by the motor. What this means is that the power must be supplied to the power assist module with correct polarity. This is easily achieved if the power is supplied via a contact-bearing member by making the cross-section of that member asymmetric so that it can only be inserted laterally into the power assist module in one orientation. In order to enable the user to choose whichever hand he or she wishes to hold the aircraft in while charging, it is convenient to mount the contact-bearing member forming part of a battery pack swivellably on the casing thereof such that it can be rotated through 180°, thus enabling the contact-bearing member to be inserted into the power assist module with the remainder of the battery pack extending to one side or the other of the fuselage.

The invention is illustrated by way of example with reference to the accompanying drawings in which:

Figure 1 is an exploded view of a power assist module for use in an aircraft in accordance with the invention.

Figure 2 is a perspective view of the power assist module and a single piece aircraft body,

Figure 3 is a perspective view of a battery pack to power up the motor and charge the charge storage device

forming part of the power assist module, Figure 3 being shown relative to Figure 2 of the drawings in the position where the user holds the aircraft body in the left hand and the battery pack in the right,

Figures 4 and 5 are diagrammatic views of an alternative embodiment, and

Figure 6 is a diagrammatic perspective view of a further alternative embodiment with wing tip rotors to enhance lift.

Referring first to Figure 1, this shows an exploded view of a power assist assembly denoted 1. As shown, this consists of a capacitor 2 having two leads 15 extending from one end which provide power to an electrical motor 3 having power terminals 16 protruding from one end of a motor casing and a drive shaft 17 protruding from the other. Fitted to drive shaft 17 is a spur gear 4 which engages when the components are assembled together with a spur gear 5 mounted on a propeller shaft 6. On the front end of shaft 6 is press fitted a propeller 7 while the shaft 6 itself is located when the components are assembled in the upper portion as shown in Figure 1 of a moulded motor housing 9. As can be readily appreciated from Figure 1, housing 9 has appropriate fitting portions which enable the motor housing to be clipped into place. The housing 9 also includes two apertures through which the leads from capacitor 15 may pass and be connected to the leads 16 on the motor housing.

Propeller shaft 6 is held axially in place by means of a friction fitted sleeve 8.

In order to consolidate the entire assembly 1 together, a heat shrinkable sleeve 20 having a side aperture 21 is fitted over the end of capacitor 2 nearer the motor

housing 9, and the housing 9 itself. It is so dimensioned that it will hold housing 9 and capacitor 2 relatively to one another coaxially and spaced apart. Aperture 21 enables access to the two leads 15 extending between capacitor 2 and the motor housing 9.

Turning now to Figure 2, this shows the assembly 1 in front of a single piece styrofoam moulding 12 which is in the shape of a toy aircraft having a fuselage 28, wings 25, tail 27 and fin 26. A moulded non-symmetrical slot 13 extends from the top of the fuselage 28 between the wings 25 down to a hollow generally cylindrical cavity 29 which extends from the front of the fuselage 28 rearwardly as shown. When the power assist module 1 is pushed back into the fuselage, it is a press fit with the aperture 21 and sleeve 20 then registering with aperture 13 in fuselage 28.

In order to provide power for the power assistance, a simple battery pack is used. This is shown in Figure 3 and identified by reference numeral 30 and it consists in standard fashion of a plastics casing surrounding four standard cells, connecting them together in series. The internal design of such battery packs is well-known and accordingly does not need to be gone into here. However, such battery packs generally have as standard either a socket into which a power lead may be plugged, or a pair of contacts on the casing fixed relative to one another and to the casing so that the entire casing may be inserted into an appropriate socket to connect the batteries within to some device requiring a supply of electrical current from those batteries.

As shown in Figure 3, the battery pack for use in conjunction with the aircraft of the present invention has a contact-bearing member 31 mounted in one end. The member 31, as shown in Figure 3, is a downwardly

depending elongate member bearing on one side a connector 34 and bearing on its opposite side a like connector which is not visible in Figure 3. Connector 34 is located on an elevated portion of member 31 and that elevated portion is designed to fit into a key configuration slot 13 at the top of the fuselage. The rear side of member 31 which is not visible in Figure 3 is flat, so it can readily be seen that the battery pack may be inserted into socket 13 one way round only, and that when so inserted, connector 34 and its oppositely lying connector make contact with the respective leads 15 extending forwardly from capacitor 2 toward motor housing 16. When this happens, electrical current from the battery pack 30 flows through motor 3 and spins the propeller in the correct sense to pull the aircraft forward. At the same time, capacitor 2 is charged. If now battery pack 30 is removed by withdrawing member 31 from socket 13, the charge in capacitor 2 continues to rotate propeller 7 via the motor in the same sense to propel the aircraft forward until that charge has been exhausted.

As shown in Figure 3, the aircraft body 12 is held in the left hand and the battery pack 30 in the right. This may not be comfortable for all users, but as indicated by arrow 32, member 31 may be swung through 180° around a pivot axis 33 thus enabling member 31 again to be inserted into socket 13, but this time with the remainder of the battery pack 30 extending across the port wing rather than the starboard wing.

By careful design, it is possible to provide a power assist toy aircraft of the general design as shown in the accompanying drawings inexpensively, but with impressive power assisted flight characteristics. In tests using a motor type FFM 20 VA (ex Mabuchi Motor), a reduction gear ratio of 3:1, the battery pack containing

4 standard cells and a capacitor 2 of capacitance 2.2 microfarads, it was found that after a little practice at launching, the range of the aircraft was up to 1000 metres in still air conditions. There is a very substantial improvement over prior art charged capacitor charge assisted aircraft. Care should obviously be taken in design to use a highly efficient motor 3, an adequate charge storage device capacitor 2 and, generally speaking, to keep the overall weight of the power assist unit down. In tests, we have found that using an appropriate motor type blank and a capacitor of adequate capacity, the complete weight of the power assist module can be as low as 10 grams and it can be fitted into a styrofoam single piece moulded aircraft body unit 12 weighing 3 grams. The entire assembly accordingly weighs around 13 grams.

Numerous variations may be made to the design of the one piece moulded unit 12, it being only necessary to provide a standard cylindrical socket 29 and charging access slot 13 common to all such designs. Because of the removability of the power assist module 1, if the aircraft portion 12 becomes damaged beyond repair, it may simply be discarded and the power assist module 1 inserted into a new one.

Referring now to Figures 4 and 5, these show in schematic perspective view and in partially axially sectioned view respectively a power-assisted aircraft in accordance with the present invention which is configured to resemble a jet-propelled aircraft rather than a propeller driven one. Many of the components are common to both units and the same reference numbers have been used for like parts. In Figure 4, the components of the power assist module are shown exploded, while in Figure 5 they are shown as they would appear.

In contrast to the embodiment described with reference to Figures 1 and 2, the power assist unit is designed to fit wholly inside the body of the aircraft and as can be seen, the cavity 29 into which the power assist module is inserted, extends from fore to aft of the lightweight integral moulding comprising the fuselage, wings and tail assembly. The cavity is stepped at 40 (see Figure 5) so that on insertion, the power assist module is correctly positioned. Correct positioning is achieved by butting a mounting ring component 38 against the step 40. Mounting ring 38 has four spokes running out to it from a central moulded housing which is adapted to receive motor 3 and support the remaining components. There is a central axial aperture through which a drive shaft from the motor protrudes, the drive shaft being fitted into the hub of an impeller fan blade 37 of diameter slightly less than that of component 38.

When the impeller 37 is driven at sufficient speed, it sucks air in at the front and blows it out at the back of the aircraft, thus giving necessary power assist. The impeller is designed to spin fast and accordingly, as shown in Figures 4 and 5, is directly coupled to the output shaft of motor 3. Otherwise, the design features remain much the same.

Although the centre of gravity of the power assist modules shown in Figures 2 and 4 is arranged to lie relatively close to the centre of gravity of the entire assembly, the power assist assembly is not entirely rotationally symmetrical about the centre line and accordingly if not inserted at precisely the right orientation, the difference can make the aircraft dip gently to one side or another when flying. This is clearly desirable. The problem is easily solved by providing internally of cavity 29 and on the exterior of the power assist module some interacting formations or

the like to ensure that appropriately accurate alignment is achieved as the power assist module is pushed in.

Referring to Figure 6, this shows a toy aircraft consisting of a fuselage 60, tail fin 61, tail plane 52, wings 63 and moulded lightweight freely rotatable wheels 64. It is powered via a power assist assembly analogous to that shown in Figure 1 which turn a propeller 65. In order to enhance performance, the end of each wing 63 carries a moulding 66 (press fitted on to the end of the wing so they can be replaced if the wing and body portion is damaged) which carries a freely rotatable rotor 67 to provide additional lift via the autogiro effect.

CLAIMS

1. An electrically power-assisted toy aircraft construction consisting of a power assist module which can be releasably attached to a single piece lightweight aircraft body such that the assembled power assist module and body constitute an aerodynamic glider and wherein the power assist module comprises a propeller, an electric motor adapted to rotate the propeller and a charge storage device adapted to power the electric motor.

2. A toy aircraft construction according to Claim 1 wherein the aircraft body is moulded out of lightweight polystyrene foam material.

3. A toy aircraft construction according to Claim 1 or 2 wherein the aircraft body takes the form of a conventional aircraft with fuselage, two wings, a tail and a fin, and wherein the body includes an aperture extending longitudinally from the front of the fuselage into which the power assist module is a press fit.

4. A toy aircraft construction according to any one of Claims 1 to 3 wherein the power assist module is constructed in the shape of a cylinder which can be press fitted into an aperture in the front of a fuselage with the propeller located on the front of a fuselage with the propeller located on the front of the assembled aircraft.

5. A toy aircraft construction according to Claim 4 wherein the power module assist consists of a linear assembly of, in sequence, a charge storage device, a motor connected thereto, a propeller drive gearing, a propeller shaft and a propeller.

6. A toy aircraft construction according to Claim 5 and wherein the linear assembly includes a reduction gear unit between the motor and the propeller shaft.

7. A toy aircraft construction according to Claim 5 or 6 wherein, in order to enable electrical charge to be supplied to the charge storage device, a pair of electrical contacts is provided located between the charge storage device and the motor which may be accessed using a suitable contact-bearing member inserted in a generally radial direction to the longitudinal axis of such a power assist unit.

8. A toy aircraft construction according to Claim 7 wherein the fuselage of the body portion of the aircraft contains an aperture located so that when the power assist module is inserted into the fuselage, the contacts are accessible via the aperture.

9. A toy aircraft construction according to any one of Claims 1 3 wherein the power assist module includes a propeller of small diameter mounted on a frame of slightly larger diameter, the frame carrying a drive motor and charge storage device.

10. A toy aircraft construction according to any one of the preceding Claims and including mounted at or near the ends of the wings a pair of freely rotatable propellers, each mounted for rotation about an axis substantially vertical when the aircraft is in substantially horizontal glide mode, whereby to generate additional lift by the use of the autogiro effect.

AMENDED CLAIMS

[received by the International Bureau on 28 November 2000 (28.11.00);
original claim 1 amended; remaining claims unchanged (2 pages)]

1. An electrically power-assisted toy aircraft construction consisting of a power assist module which can be releasably attached to an aircraft body such that the assembled power assist module and body constitute an aerodynamic glider and wherein the power assist module comprises a propeller, an electric motor adapted to rotate the propeller and a charge storage device adapted to power the electric motor, characterised in that the aircraft body is a single piece lightweight moulding into which the power assist module may be inserted.

2. A toy aircraft construction according to Claim 1 wherein the aircraft body is moulded out of lightweight polystyrene foam material.

3. A toy aircraft construction according to Claim 1 or 2 wherein the aircraft body takes the form of a conventional aircraft with fuselage, two wings, a tail and a fin, and wherein the body includes an aperture extending longitudinally from the front of the fuselage into which the power assist module is a press fit.

4. A toy aircraft construction according to any one of Claims 1 to 3 wherein the power assist module is constructed in the shape of a cylinder which can be press fitted into an aperture in the front of a fuselage with the propeller located on the front of a fuselage with the propeller located on the front of the assembled aircraft.

5. A toy aircraft construction according to Claim 4 wherein the power module assist consists of a linear assembly of, in sequence, a charge storage device, a motor connected thereto, a propeller drive gearing, a

propeller shaft and a propeller.

6. A toy aircraft construction according to Claim 5 and wherein the linear assembly includes a reduction gear unit between the motor and the propeller shaft.

7. A toy aircraft construction according to Claim 5 or 6 wherein, in order to enable electrical charge to be supplied to the charge storage device, a pair of electrical contacts is provided located between the charge storage device and the motor which may be accessed using a suitable contact-bearing member inserted in a generally radial direction to the longitudinal axis of such a power assist unit.

8. A toy aircraft construction according to Claim 7 wherein the fuselage of the body portion of the aircraft contains an aperture located so that when the power assist module is inserted into the fuselage, the contacts are accessible via the aperture.

9. A toy aircraft construction according to any one of Claims 1 3 wherein the power assist module includes a propeller of small diameter mounted on a frame of slightly larger diameter, the frame carrying a drive motor and charge storage device.

10. A toy aircraft construction according to any one of the preceding Claims and including mounted at or near the ends of the wings a pair of freely rotatable propellers, each mounted for rotation about an axis substantially vertical when the aircraft is in substantially horizontal glide mode, whereby to generate additional lift by the use of the autogiro effect.

STATEMENT UNDER ARTICLE 19(1)

Old claim 1 has been amended by reordering its content and placing it into two part form clearly to distinguish from the disclosures of the more relevant of the documents identified in the international search report. The impact of this on the text of the case will lead in due course to the amendment of the statement of invention appearing at page 3, lines 18 to 27.

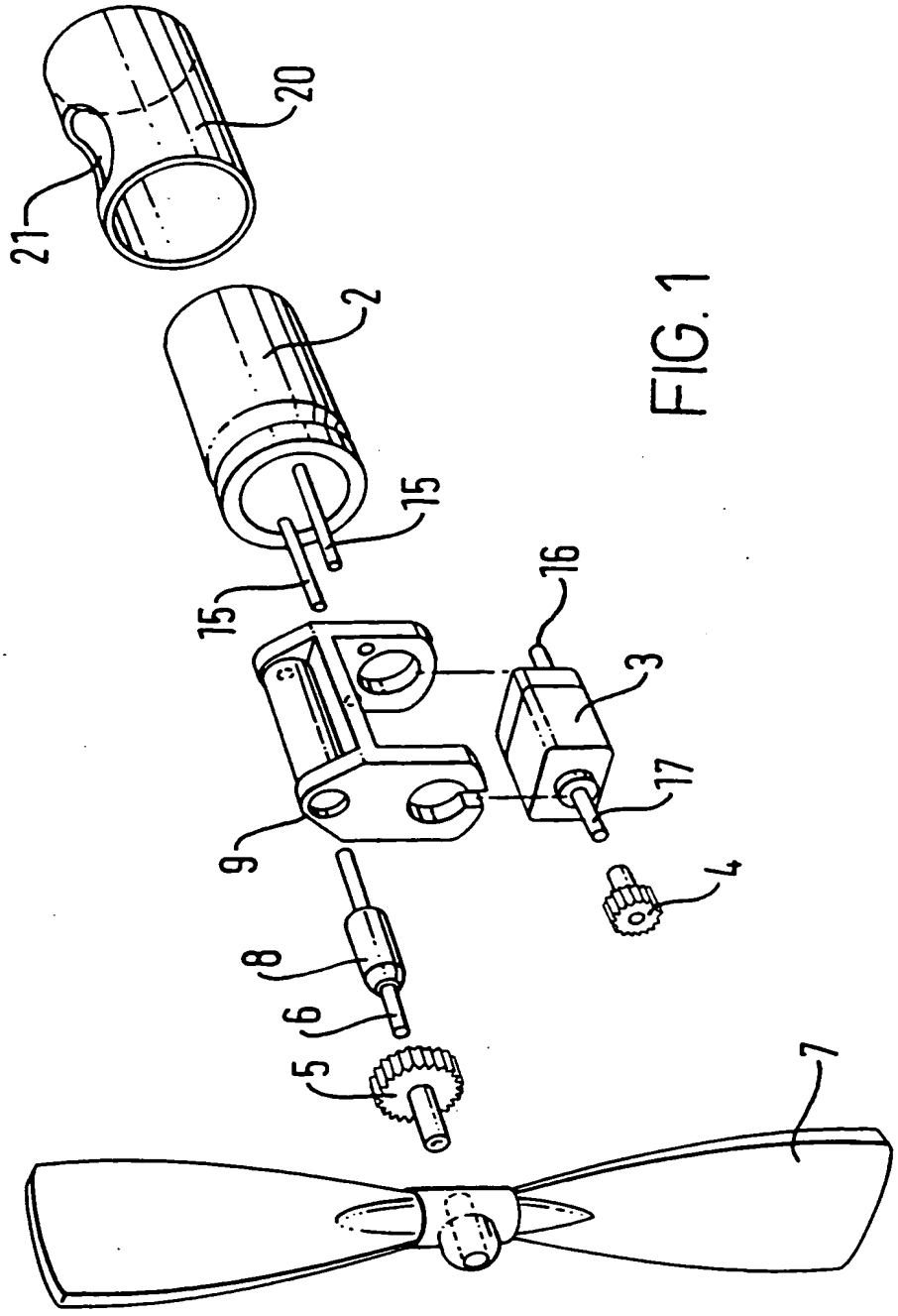

FIG. 1

FIG. 3

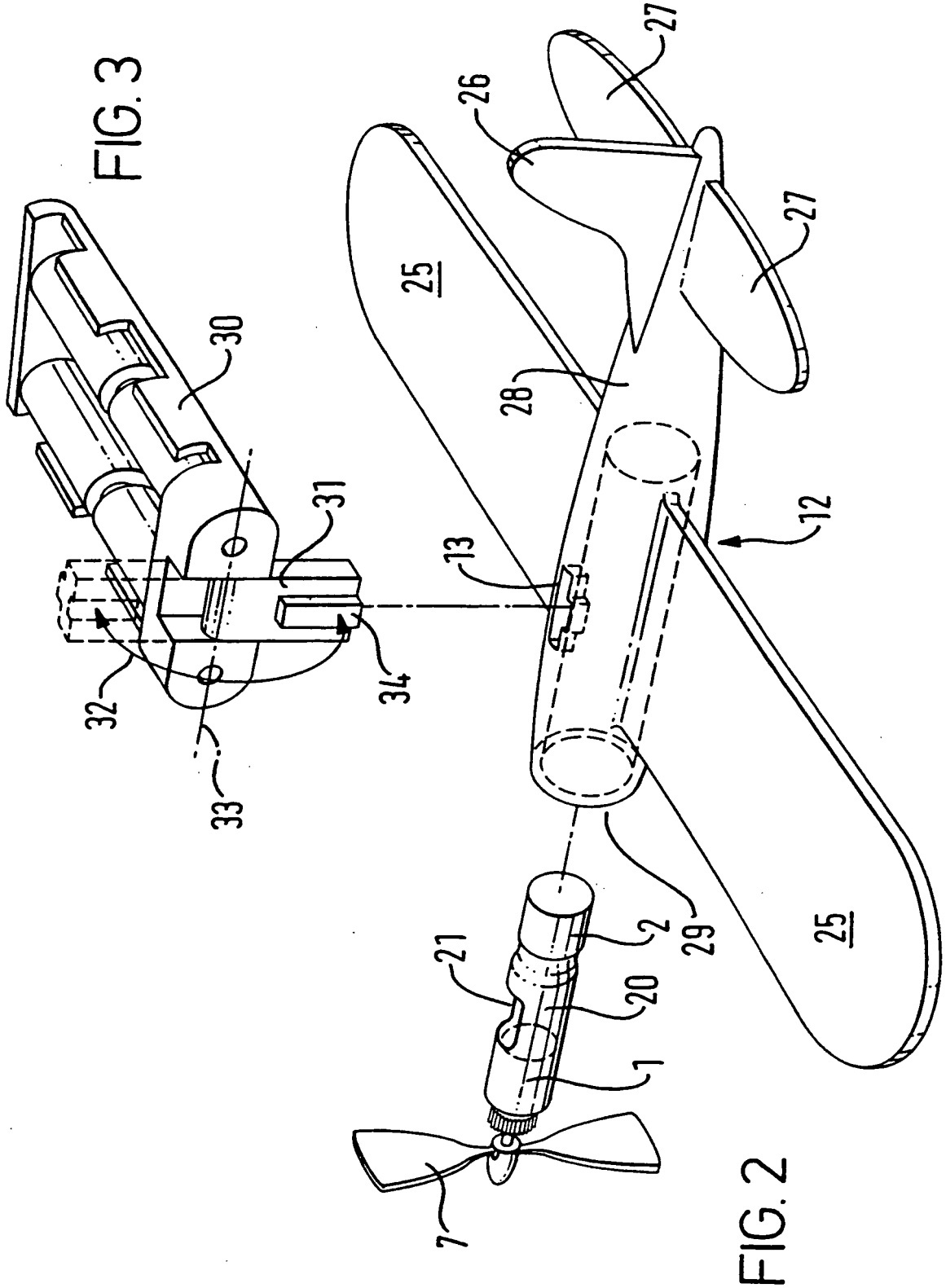

FIG. 2

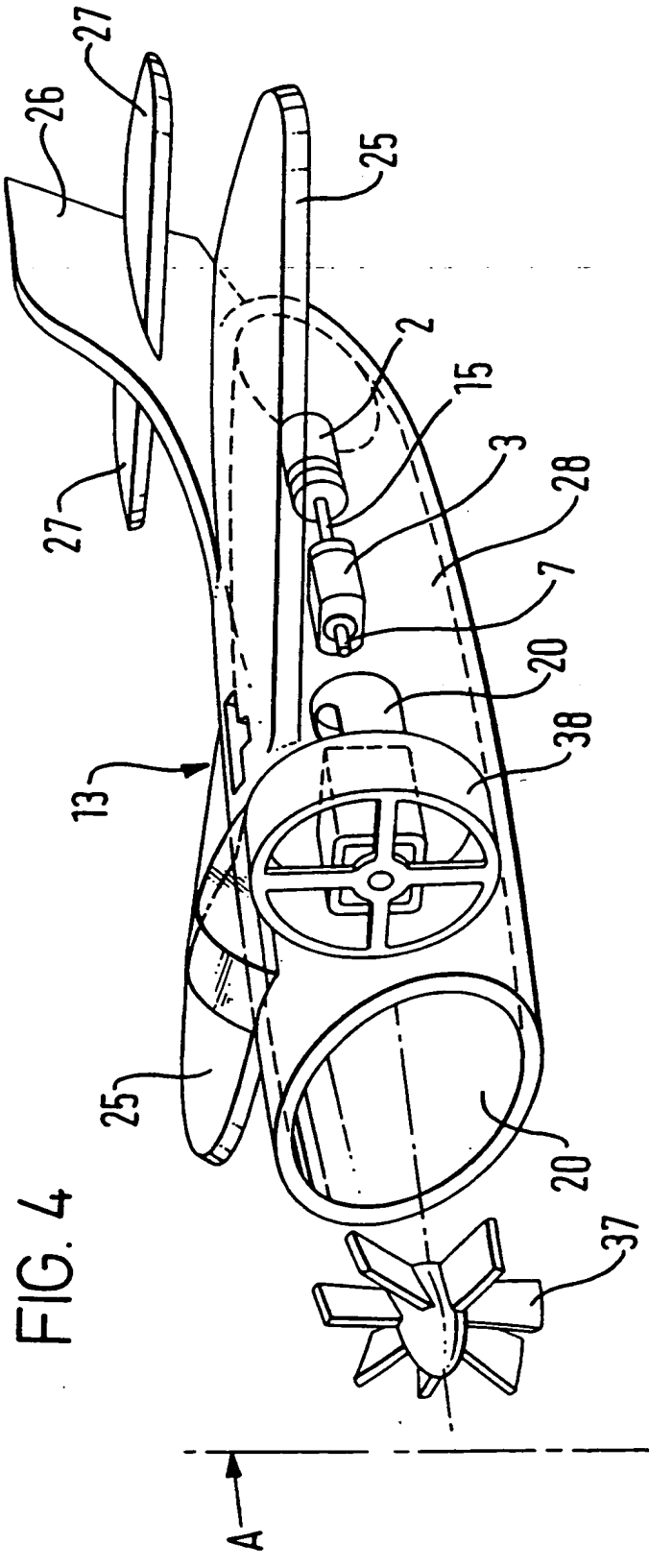

FIG. 4

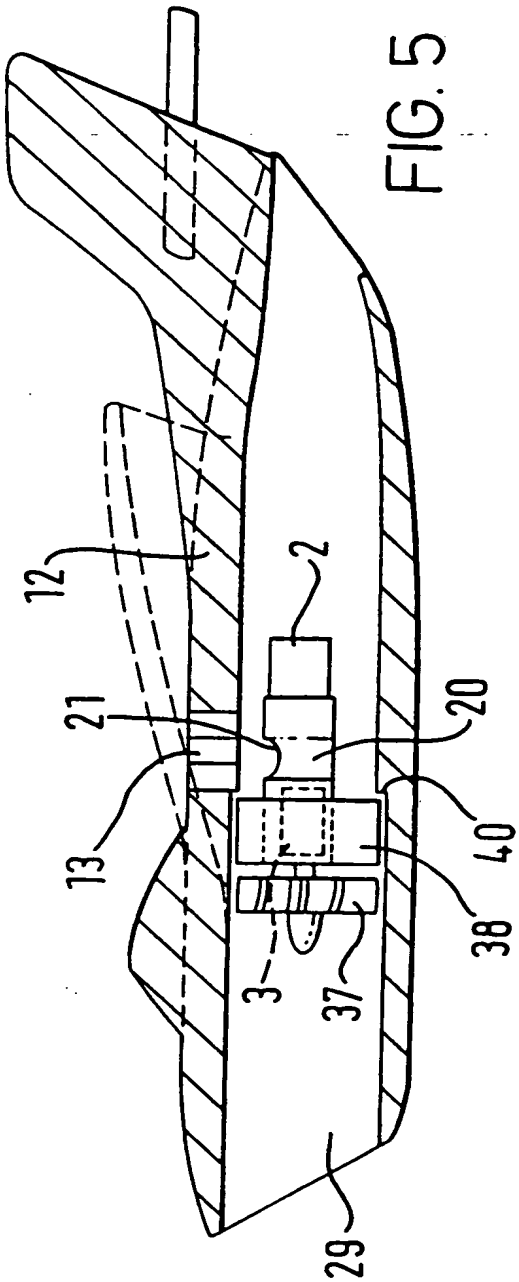

FIG. 5

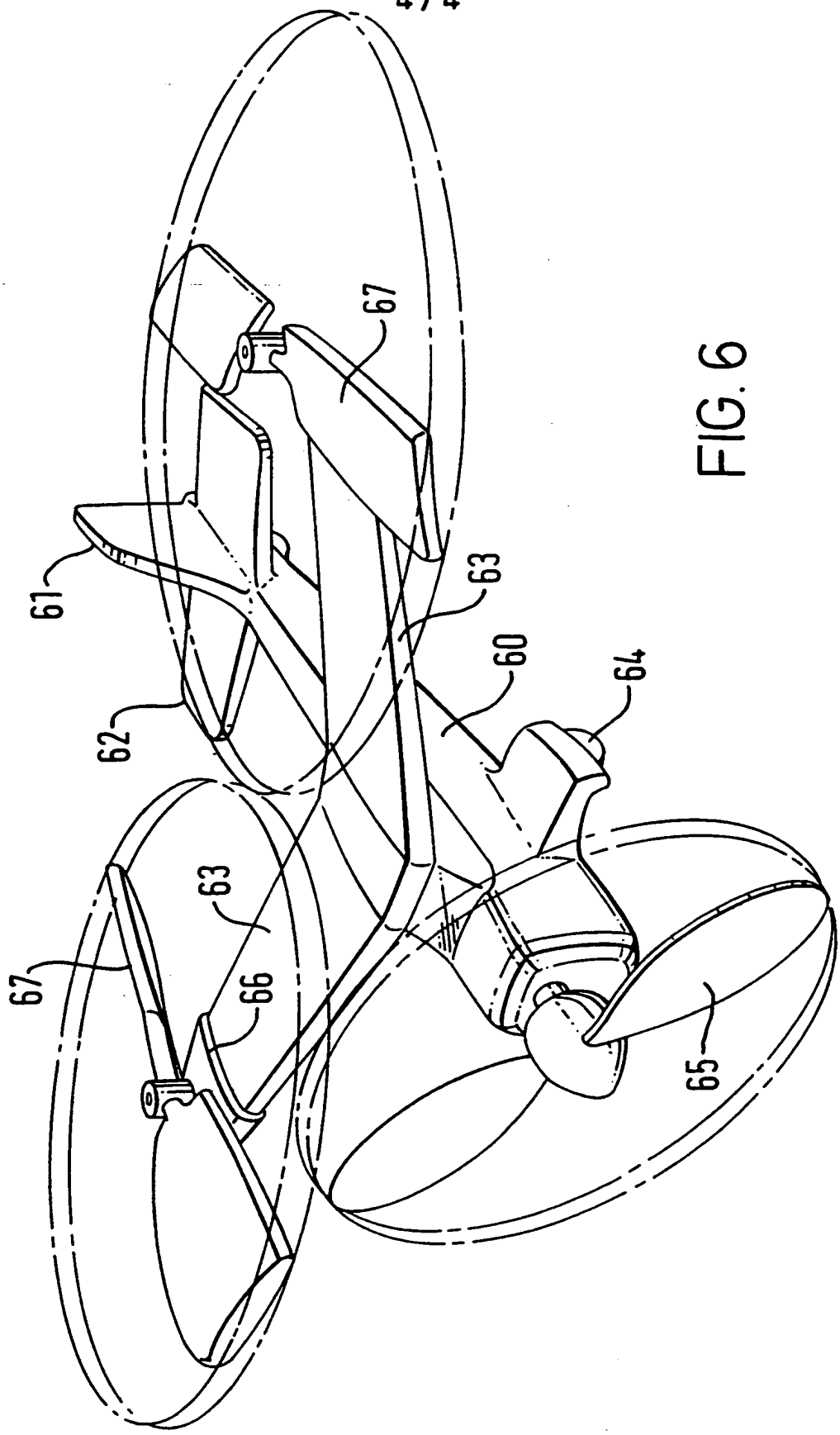

FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02650

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A63H27/18 A63H27/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 3 777 420 A (BOSLEY D ET AL) 11 December 1973 (1973-12-11) column 1, line 44 -column 2, line 34 column 3, line 38 -column 4, line 66 column 6, line 63 -column 7, line 12 figures 1,2	1 2-6 7,8
Y	GB 2 104 788 A (HILVENNA LTD) 16 March 1983 (1983-03-16) page 1, right-hand column, line 72-89 page 2, right-hand column, line 68-79 page 3, left-hand column, line 49-55 figures 1-6	2-6

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2000	28/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Salvignol, A

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02650

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 078 638 A (MOLINA JOSEPH) 7 January 1992 (1992-01-07)	1
A	column 1, line 56-62 column 4, line 33-36 column 5, line 57 -column 6, line 5 column 8, line 42-45 claims 1,2; figures 1-5	3,4,7
A	US 4 895 541 A (MILLER WILLIAM H) 23 January 1990 (1990-01-23) column 2, line 11-20 column 4, line 7-14 column 4, line 43-52 figures 1-6	1,2,5,6
A	US 4 850 535 A (IVIE PAUL B) 25 July 1989 (1989-07-25) column 4, line 35-54; figure 1	9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ational Application No
PCT/GB 00/02650

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3777420 A	11-12-1973	NONE	
GB 2104788 A	16-03-1983	NONE	
US 5078638 A	07-01-1992	NONE	
US 4895541 A	23-01-1990	WO 8904707 A AU 2265588 A	01-06-1989 14-06-1989
US 4850535 A	25-07-1989	NONE	

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